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INTRO

Robotic Arm Control Using Haptic glove

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- The project of Robotic Arm controlled via Haptic Glove is a system by which a user can control a remotely placed robotic arm via the haptic glove controller.
- We are including a way by which the user shall send the angle of each finger to the arm via the google firebase cloud.
  - Google Firebase cloud serves as a real time database where each time the data changes it is fed to the cloud via the glove's esp8266 module which we have preloaded with the security keys ,access url of the database in order to make it secure.
  - This access key and the secret key is also shared with the robotic arm by which it receives this data and moves the robotic arm accordingly.
- The focus of this project was to make a robotic arm which can make almost all the gestures which a normal arm could possibly make, to name one of the custom motions we have developed is an abduction mechanism which allows the user to flex his Intrinsic muscles Lumbricals and interossei.

INTRO

INTRODUCTION

Objective:

As a beneficial solution to the aforementioned issue, certain factors are required to be considered before designing a well stabilized arm and glove.

- **Scalability** – This refers to the scenario where there could be multiple robotic arms and gloves. The communication between them must be perfected so that they do not control/get controlled by another arm/glove.
- **Reliability** – Being a safe and secure system with features to make sure that no damage could happen to the arm because of the force/temperature exerted on it despite the controller of the arm physically not being present there/arm is not visible to him.
- **Cost** – To address the issue of lack of reliability in a cheaper solution to prosthetics system generally used, the solution must be capable of proving to be for a custom 3d printed model cost effective.

INTRODUCTION

Objective:

- **Maintenance** – Considering that the area of application is to be generic and thus even for organizations with low resources, the system must require less maintenance which can be easily done as required. Components of the prosthetic must be easily changeable in case of damage to only part of the existing robotic arm.
- **Ease of use** – As this system could be implemented in any field, the system should be easy to use by any person, with any level of education or training. The system must not be too complex for an authorized person to use.

Taking all these factors into consideration, the solution proposed is a custom 3-D printed **Robotic arm which is controlled by a haptic glove.**

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Components we used:

- **Arduino:**

  Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

- **Accelerometer(ADXL-345) :**

  The ADXL345 is a low-power, 3-axis MEMS accelerometer modules with both I2C and SPI interfaces. The Adafruit Breakout boards for these modules feature on-board 3.3v voltage regulation and level shifting which makes them simple to interface with 5v microcontrollers such as The ADXL345 features 4 sensitivity ranges from +/- 2G to +/- 16G.

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Components we used:

- **Servos:**

A servomotor is a closed-loop servomechanism that uses position feedback to control its motion and final position. The input to its control is a signal (either analogue or digital) representing the position commanded for the output shaft.

- **Temperature Sensor(BME-280):**

Temperature measurement can be enabled via the bme 280 it is placed right in the centre of our palm. The BME280 is an integrated environmental sensor developed specifically for mobile applications where size and low power consumption are key design constraints. The unit combines individual high linearity, high accuracy sensors for pressure, humidity and temperature in an 8-pin metal-lid 2.5 x 2.5 x 0.93 mm^3 LGA package, designed for low current consumption (3.6 μA @1Hz), long term stability and high EMC robustness.
The humidity sensor features an extremely fast response time which supports performance requirements for emerging applications such as context awareness, and high accuracy over a wide temperature range.

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Components we used:

- **FSR Sensor:**

FSRs are sensors that allow you to detect physical pressure, squeezing and the weight being exerted on it. The FSR is made of 2 layers separated by a spacer. The more one presses, the more of those Active Element dots touch the semiconductor and that makes the resistance go down.

Resistance range: Infinite/open circuit (no pressure), 100KΩ (light pressure) to 200Ω (max. pressure)

Force range: 0 to 20 lb. (0 to 100 Newtons) applied evenly over the 0.125 sq in surface area

- **Wifi module (ESP8266 on nodemcu) :**

ESP8266EX is capable of functioning consistently in industrial environments, due to its wide operating temperature range. With highly-integrated on-chip features and minimal external discrete component count, the chip offers reliability, compactness and robustness.

INTRO

INTRODUCTION

Materials we used:

- **PLA:**
  - Polylactic Acid, commonly known as PLA, is one of the most popular materials used in desktop 3D printing.
  - It is the default filament of choice for most extrusion-based 3D printers because it can be printed at a low temperature and does not require a heated bed.
  - PLA is a great first material to use as you are learning about 3D printing because it is easy to print, very inexpensive, and creates parts that can be used for a wide variety of applications.
  - It is also one of the most environmentally friendly filaments on the market today. Derived from crops such as corn and sugarcane, PLA is renewable and most importantly biodegradable. As a bonus, this also allows the plastic to give off a sweet aroma during printing.
- **Fish wire/bait wire:**

It is extremely hardy variety form of thread whose life would be more this is used to fold/unfold each finger.

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ROBOTICS ARM CONTROL USING HAPTIC TECHNOLOGY:

PAPER 1

IDEA

This paper served as basic ideology and inspiration

- Vipul J. Gohil, Dr. S D. Bhagwat, Amey P. Raut3, Prateek R. Nirmal have worked on "ROBOTICS ARM CONTROL USING HAPTIC TECHNOLOGY.
- Robots of the current generation have been used in fields isolated from the human society.
- The main objective of the project is to design and develop the Robot that is used to move using wireless system by recognizing hand motion that is controlled by haptics technology for virtual environment & human-machine systems capable of haptic interaction.
- The proposed system is utilized to recognize the human motion. Large potential for applications in critical fields as well as for leisurely pleasures. Haptic devices must be smaller so that they are lighter, simpler and easier to use. Haptic technology allows interactivity in real-time with virtual objects."

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PAPER 2

DIRECTION

Helped to give us direction to the project

Flex Sensor Based Robotic Arm Controller Using Micro Controller

- Abidhusain Syed, Zamrrud Taj H. Agasbal, Thimmannagouday Melligeri, Bheemesh Gudur worked on "Flex Sensor Based Robotic Arm Controller Using Micro Controller".
- Sensor plays an important role in robotics. Sensors are used to determine the current state of the system. Robotic applications demand sensors with high degrees of repeatability, precision, and reliability.
- Flex sensor is such a device, which accomplish the above task with great degree of accuracy. The pick and place operation of the robotics arm can be efficiently controlled using micro controller programming.
- Unlike which employ FPGA based control. Micro controller based programs can be flexibly modified to suit the necessary drive control of the serve motor.

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Design of a Haptic Arm Exoskeleton for Training and Rehabilitation

PAPER 3

ARM DESIGN

Gave us a sense as to how our arm should look.

- Abhishek Gupta, Student Member, IEEE, and Marcia K. O'Malley, Member, IEEE worked on "Design of a Haptic Arm Exoskeleton for Training and Rehabilitation".
- In this paper, the authors present a detailed review of the requirements and constraints that are involved in the design of a high-quality haptic arm exoskeleton.
- This paper presents the first iteration of the design of a haptic arm exoskeleton for rehabilitation and training.
- There exist no singularities in the workspace of the robot. The arm-centred design results in a compact interface that does not compromise natural arm movements. The alignment of human and robot axes permits easy measurement of human arm joint angles along with increased control over independent feedback to individual human arm joints.

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Arm

Motions that should be capable to be performed.

Gesture Control Robotic Arm Using Flex Sensor:

- Waseem Afzal, Shamas Iqbal, Zanib Tahira, Mehtab Ejaz Qureshi worked on"Gesture Control Robotic Arm Using Flex Sensor".
- The design and implementation of a gesture control robotic arm using flex sensor is proposed. The robotic arm is designed in such a way that it consists of four movable fingers, each with three linkages, an opposing thumb, a rotating wrist and an elbow.
- The robotic arm is made to imitate the human hand movements using a hand glove. The hand glove consists 5 flex sensor for controlling the finger movements and an Accelerometer.
- The actuators used for the robotic arm are servo motors. The finger movements are controlled using cables that act like the tendons of human arm. The robotic arm is controlled from a distant location using a wireless module.

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JAN

SURVEY

SURVEY OF AVAILABLE RESOURCES,AND EXISTING MODELS

FEB

TESTING

TESTING IDEAS AND VERIFY IF THEY ARE VIABLE

MARCH

PRINTING

PRINTING ROBOTIC ARM FROM THE DESIGNS WE DEVLOPED IN SOLIDWORKS POST SIMULATION

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APRIL
REPRINT AND GLOVE
REPRINT OF FEW PARTS AND INTEGRATION WITH THE GLOVE

MAY
INTEGRATION
INTEGRATION OF THE GLOVE WITH THE ARM AND THE APP.

JUNE
FUTURE WORK
DESIGN OF FEW OTHER JOINTS
WRITHING A JOURNAL PAPER.

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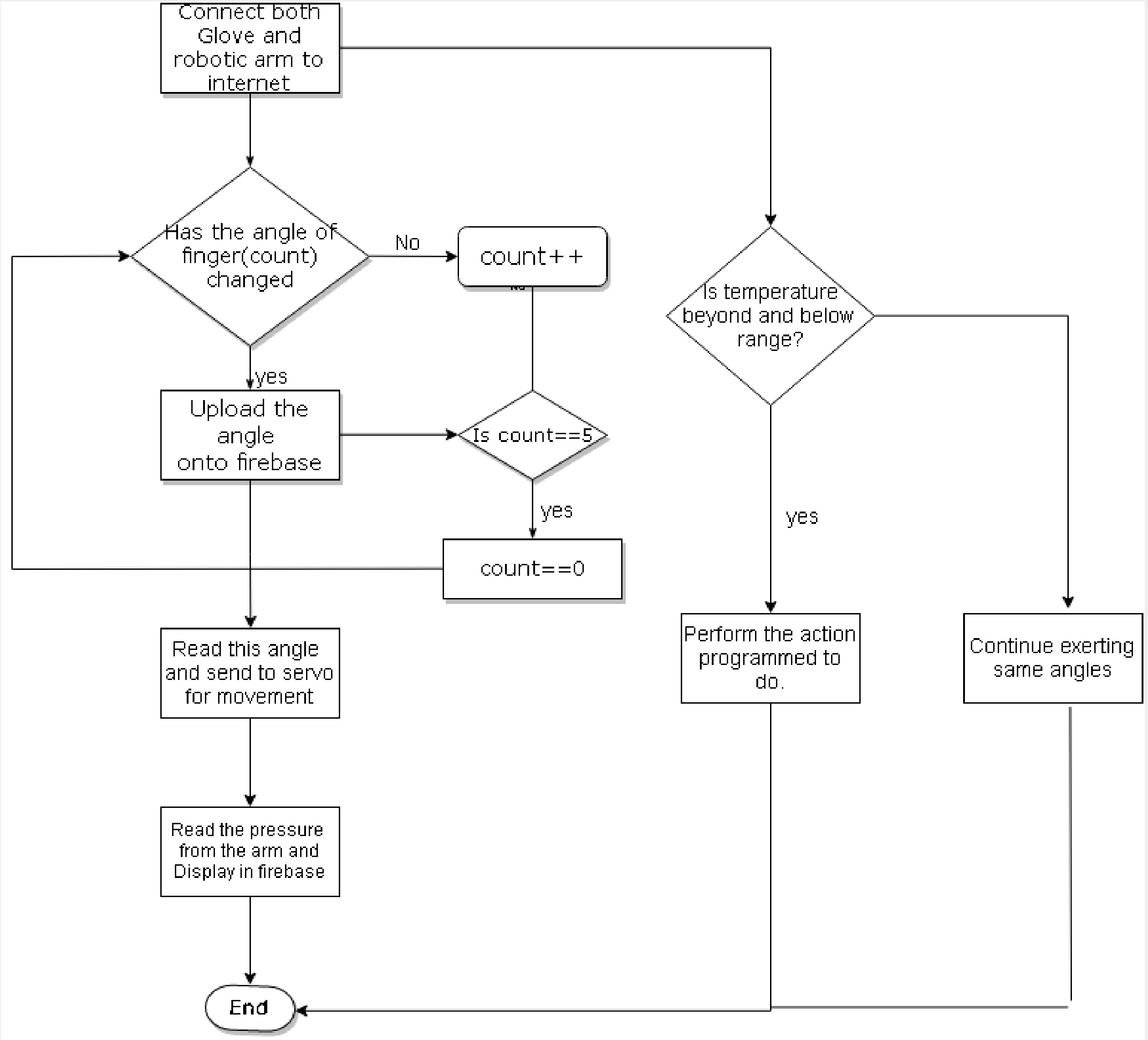
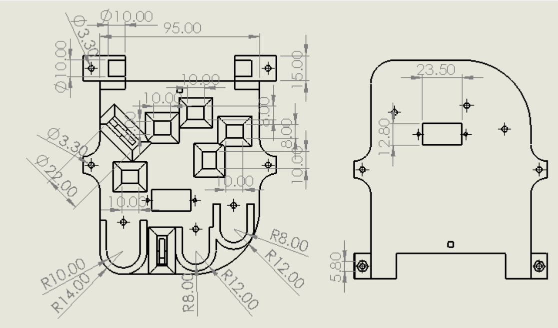
METHODOLOGY AND IMPLEMENTATION



METHODOLOGY AND IMPLEMENTATION

- If the flex has varied then the angle is fed from the adxl. The robotic arm on the other end after retrieving these angles has to manipulate the servos in order for in to reach the same angle on the arm as well. This process will be happening continuously throughout the arm is being controlled.
- Another section will be the feedback from the arm to the robotic glove. This feedback includes the temperature of the object that the user is holding onto and the pressure with which he is holding the object. Both of these also are uploaded onto the firebase, so we will have a dashboard where the user can keep monitoring these parameters and decide on what action he would like to take.
- The safety feature kicks in when the object being held can be damaging to the arm. This feature can easily be overridden.

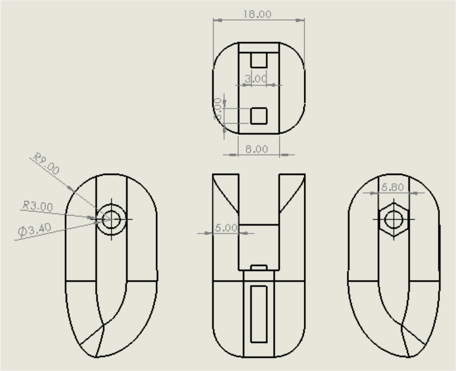
01



PALM

PALM WAS DESIGNED WITH A PLACE TO HOST THE BME SENSOR. ALSO,PLACE FOR ALL THE THREADS TO BE CHANNELLED.

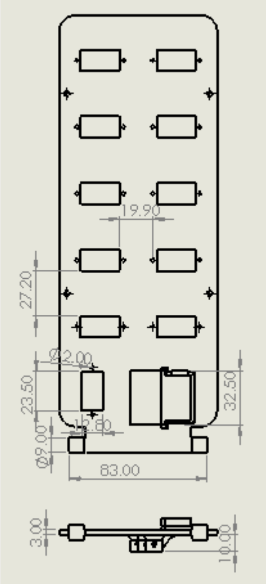
02



FINGERS

ALL THE FINGERS HAD TO BE DESIGNED UNIQELY AS ALL THEIR SIZES AND SHAPES VARRIED ALSO THE STRENGHT IN EACH OF THEM IS DIFFERENT FOR COST SAVINGS

03

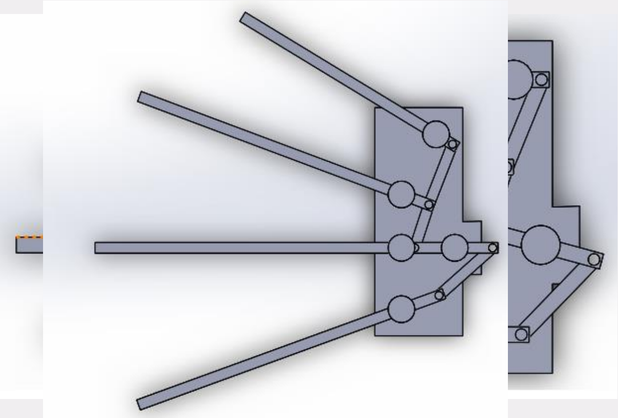


SERVO MOUNT

THE SERVO MOUNT HAD TO BE DESIGNED WITH ATMOST CARE TO HOLD THE SERVOS TIGHT ENOUGH, BUT LOOSE ENOUGH FOR EASY REPLACEMENT.

ABDUCTION MECHANISM

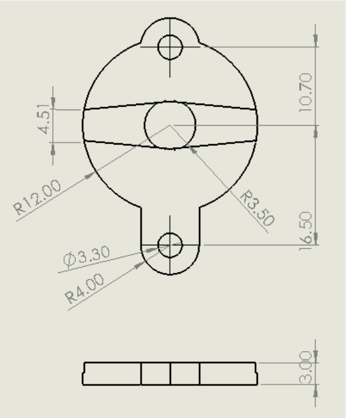
01



Abduction

Abduction action is part of Humanoid robotic arm. Abduction is necessary to vary between holding cylindrical or spherical object.

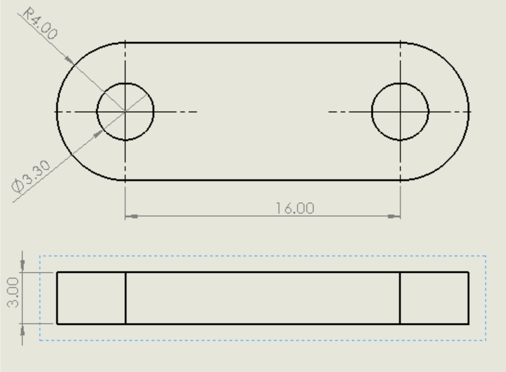
02



Servo Cover

Servo cover is main actuation for the abduction mechanism. Servo cover is the rotory link for the abduction mechanism

03



FINGER LINK

Finger is the used to connect the finger to the servo cover to transfer the rotational motion of the servo to the abduction motion of all fingers.

RESULTS

Glove

- The Haptic Glove is the controller for the robotic arm it comprises of ADXL-345 sensors placed on the fingertips of the glove to read the angle that the finger is making. The sensors have been placed in a round robin fashion to read the values from it and place them in the firebase database.
- We have placed flex sensor on this glove in order to less complicate the polling once the resistance changes only then the adxl gives the angle measured from the finger which will be replicated in the glove.

Glove

- The haptic glove can be placed in any distance from the robotic arm but can still perform its duty to read and communicate with the arm in order to make it move.
- The haptic glove user can also monitor the status of the robotic arm by using the monitor to see the temperatures of the object which is in contact with the arm, by which he could come to a decision to either continue holding it or let go.
- The robotic arm also comes with a safety feature by which it will automatically let go of the object if it determines it to be damaging to the arm in any fashion. This feature could be turned off at the owner's own risk.
- We determined adxl-345 to be the best fit for our glove as it is capable of noticing changes in 3 of its axis, so say you use the abduction, the angle of the finger does not change but the position of it does. This kind of complex movements can be most effectively be recorded by using only the adxl-345 as it's a 3-d axis accelerometer.

Results and Conclusion

The final outcome of the project is an easy-to-use, secure Robotic Arm which can be controlled via a haptic glove.
The problems to overcome were many during this project like:

- Delay in communication between the glove and the arm.
- Material used for printing was found to be of wrong type and settings used were wrong, making the hand brittle.
- The joint to move the entire palm was not working as expected.
- The servo bed was designed wrong due to which the servos could not sit stably.
- The Abduction mechanism was not working as expected from the solid work simulation.
- Found many more factors which weigh in for the design as reality varies from simulation.

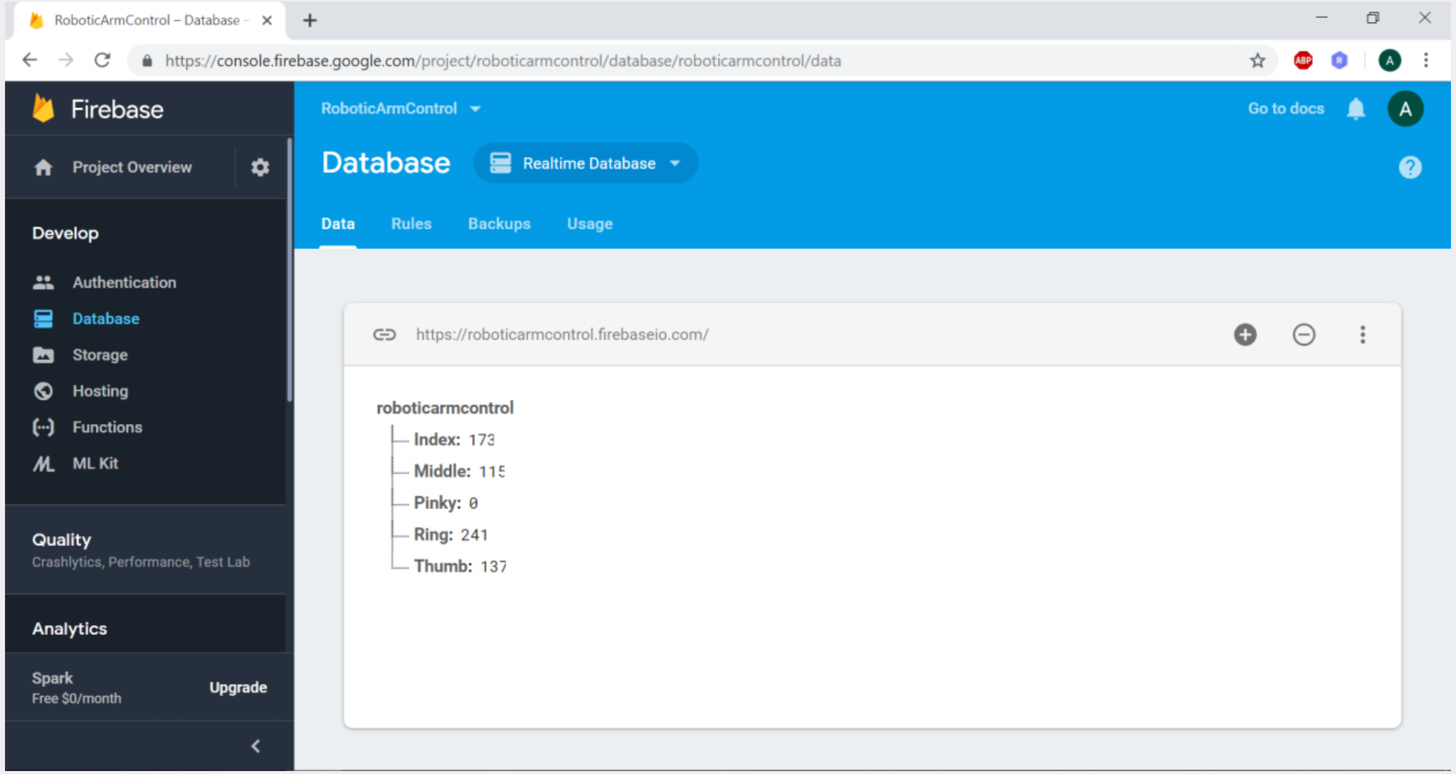
Results and Conclusion

But after overcoming the issues discussed previously by

- Slowly resolving them.
- Making the arm look more pleasing to the eye.
- Proper design and integration of the servo bed and the servos.

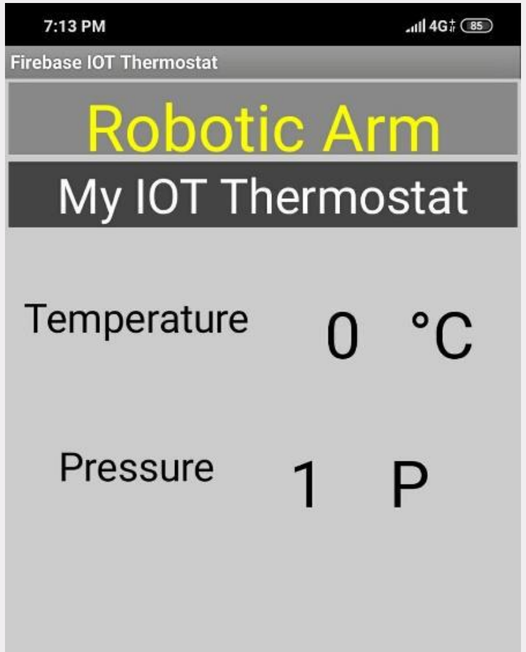
Our arm was finally ready.

Real-Time Database mid point for arm & glove



The above is he snapshot of the real-time cloud database which store the values to be supplied to the haptic glove. We have used this as it is extremely secure and also breaks the limitation of distance between the glove and the arm.

Real-Time App



- The arm comes equipped with a temperature and pressure sensor. So these values are stored onto the cloud in real-time.
- We have also made an app which is updated in real time. This can be used to monitor the condition of the arm and see if the object is too dangerous to continue gripping.

Future work:

There are many directions this project could venture into. Few of our ideas on how we could possibly continue this project are listed below.

- The robotic arm which can perform more and more complex motions and make the arm look more appealing to the eye. The design right now was to serve as a proof of concept due to which even though not aesthetically looking good serves our purpose as all the joints were designed after meticulous testing and literature survey and experiments on holding various objects with our own hand.
- We would also like to remove the use of the robotic glove so it could be controlled via emg signals produced by the brain. As this would serve as an outstanding prosthetic.

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Future work:

There are many directions this project could venture into. Few of our ideas on how we could possibly continue this project are listed below.

- The complexity that this arm can reach is to the level that a doctor should be able to perform complex surgeries on a patient sitting in a whole other country perhaps. For this to be achieved the glove and the arm movements must be perfected as one small slip up could result in possible death. This feature allows doctors to perform more intricate surgeries and also operate on patients on a earlier time by which the rate of survival may shoot up. By reducing the contact of humans during the operation reduces the chance of post-surgery infections for the patients as the robot can be more easily sterilized as compared to the human doctor, this reduces chances of the doctor also contracting dangerous diseases if the patient has a contagious form of disease.

THANK YOU